

Do surgical emergencies stay at home? Observations from the first United States Coronavirus epicenter

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BACKGROUND:	During the coronavirus disease 2019 pandemic, New York instituted a statewide stay-at-home mandate to lower viral transmission. While public health guidelines advised continued provision of timely care for patients, disruption of safety-net health care and public fear have been proposed to be related to indirect deaths because of delays in presentation. We hypothesized that admissions for emergency general surgery (EGS) diagnoses would decrease during the pandemic and that mortality for these patients would increase.
METHODS:	A multicenter observational study comparing EGS admissions from January to May 2020 to 2018 and 2019 across 11 NYC hospitals in the largest public health care system in the United States was performed. Emergency general surgery diagnoses were defined using <i>International Classification Diseases, Tenth Revision</i> , codes and grouped into seven common diagnosis categories: appendicitis, cholecystitis, small/large bowel, peptic ulcer disease, groin hernia, ventral hernia, and necrotizing soft tissue infection. Baseline demographics were compared including age, race/ethnicity, and payor status. Outcomes included coronavirus disease (COVID) status and mortality.
RESULTS:	A total of 1,376 patients were admitted for EGS diagnoses from January to May 2020, a decrease compared with both 2018 (1,789) and 2019 (1,668) ($p < 0.0001$). This drop was most notable after the stay-at-home mandate (March 22, 2020; week 12). From March to May 2020, 3.3%, 19.2%, and 6.0% of EGS admissions were incidentally COVID positive, respectively. Mortality increased in March to May 2020 compared with 2019 (2.2% vs. 0.7%); this difference was statistically significant between April 2020 and April 2019 (4.1% vs. 0.9%, $p = 0.045$).
CONCLUSION:	Supporting our hypothesis, the coronavirus disease 2019 pandemic and subsequent stay-at-home mandate resulted in decreased EGS admissions between March and May 2020 compared with prior years. During this time, there was also a statistically significant increase in mortality, which peaked at the height of COVID infection rates in our population. (<i>J Trauma Acute Care Surg</i> . 2021;91: 241–246. Copyright © 2021 Wolters Kluwer Health, Inc. All rights reserved.)
LEVEL OF EVIDENCE:	Epidemiological, level IV.
KEY WORDS:	Emergency general surgery; New York City; COVID-19 pandemic.

In the last days of 2019, a novel coronavirus emerged in Wuhan, China, which quickly spread across the globe.¹ The first confirmed case of coronavirus disease 2019 (COVID-19) in New York City (NYC) was reported on February 29, 2020.² Eleven days later, the World Health Organization declared COVID-19 a worldwide pandemic³; by that time, NYC already had more than 200 reported cases, as well as its first COVID-related deaths.⁴ Within 2 months, there were more than 200,000 confirmed cases in NYC, more than any other city in the world.²

As NYC quickly became the first COVID epicenter of the United States, New York State Governor Andrew Cuomo issued

the New York State on PAUSE executive order on March 22, 2020. This “stay-at-home” mandate ordered the closure of all nonessential businesses and enacted “social distancing” in an effort to protect the most vulnerable members of the population.⁵ The mandate remained in place until June 8, 2020, when NYC began its phase 1 of Governor Cuomo’s plan for reopening.⁶ During this time, COVID-19 cases overwhelmed the health care system, peaking at more than 5,000 new cases per day.² Elective surgery was widely canceled in early March to offload hospital resources; however, hospitals and professional societies maintained that timely surgical care be provided for emergent surgical conditions.^{7,8} Despite this recommendation, there was an observed decrease in emergency general surgery (EGS) admissions. This trend was reflected by an overall decline in US emergency department visits, down 42% compared with the prior year.⁹ While COVID-19 consumed the health care system, there was growing concern that public fear surrounding the pandemic was keeping sick patients from seeking essential care, resulting in delayed presentation for life-threatening conditions, potentially leading to unnecessary non-COVID deaths.^{10–12}

The New York City Health and Hospitals (NYC H + H) network is the largest municipal health care system in the United States. Spread across the city’s five boroughs, NYC H + H serves as a safety-net system for 1.4 million patients every

Submitted: December 1, 2020, Revised: February 6, 2021, Accepted: February 24, 2021, Published online: March 30, 2021.

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This study was presented at the 34th EAST Annual Scientific Assembly, Virtual #EAST2021, January 13–14, 2021.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text, and links to the digital files are provided in the HTML text of this article on the journal’s Web site (www.jtrauma.com).

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DOI: 10.1097/TA.0000000000003202

J Trauma Acute Care Surg
Volume 91, Number 1

year, including nearly 500,000 uninsured patients.¹³ New York City Health and Hospitals consists of 11 unique and functionally independent acute care hospitals, 6 long care facilities, and multiple community centers. This offers a unique opportunity to study the effect of the COVID-19 pandemic on EGS admissions across a multi-institutional system hard hit at the peak of its impact. We hypothesized that admissions for EGS diagnoses would decrease during the pandemic. Based on the assumption that patients would delay their care, we also hypothesized that mortality for these patients would increase compared with prior years.

PATIENTS AND METHODS

Following institutional review board approval, data were collected and queried from billing records across all 11 NYC H + H acute care hospitals. Common EGS diagnoses with corresponding *International Classification Diseases, Ninth Revision*, diagnosis and procedure codes were chosen based on published

data.¹⁴ These codes were then converted to *International Classification Diseases, Tenth Revision, Clinical Modification* and grouped into seven diagnoses categories: appendicitis, cholecystitis, intestinal (including all indications for urgent small and large bowel resections), peptic ulcer disease, groin hernias, ventral hernias, and necrotizing soft tissue infection (Supplemental Digital Content, Tables 1 and 2, <http://links.lww.com/TA/B974>). All inpatients with these diagnoses admitted between January and May for years 2018 to 2020 were studied. Patient data abstracted from the common system-wide billing record included age, sex, race/ethnicity, insurance payor status, COVID status, length of stay, and in-hospital mortality. To analyze EGS admissions in 2020, a weekly rolling average was used to track patterns of hospital admission over the 5-month time period in all 3 years.

Statistical analyses were performed using SAS software version 9.4 (SAS Institute Inc., Cary NC). Descriptive statistics were calculated for all measured variables by year of admission.

TABLE 1. Patient Characteristics

	2018 (n = 1,789) n (%)	2019 (n = 1,668) n (%)	2020 (n = 1,376) n (%)	2020 (N = 1,376)	
				COVID	
				Negative (n = 1,324) n (%)	Positive (n = 52) n (%)
Age, median (IQR) [range]	53.0 (30.0) [15–102]	53.0 (30.0) [15–102]	54.0 (30.0) [15–100]	54.0 (30.0) [15–100]	55.5 (20.5) [20–98]
Sex, n (%)					
Female (n = 2,282)	847 (47.3)	801 (48.0)	634 (46.1)	615 (46.5)	19 (36.5)
Male (n = 2,551)	942 (52.7)	867 (52.0)	742 (53.9)	709 (53.6)	33 (63.5)
Payor (missing, 6), n (%)					
Commercial (n = 696)	208 (11.7)	246 (14.8)	242 (17.6)	236 (17.9)	6 (11.5)
Government (n = 3,891)	1,454 (81.4)	1,359 (81.5)	1,078 (78.5)	1,032 (78.1)	46 (88.5)
Self-pay (n = 240)	124 (6.9)	62 (3.7)	54 (3.9)	54 (4.1)	0 (0.0)
Race (missing, 1), n (%)					
Asian (n = 279)	106 (5.9)	95 (5.7)	78 (5.7)	77 (5.8)	1 (1.9)
Black (n = 1,472)	548 (30.6)	509 (30.5)	415 (30.2)	404 (30.5)	11 (21.2)
White (n = 555)	210 (11.7)	178 (10.7)	167 (12.2)	161 (12.2)	6 (11.5)
Other (n = 2,111)	693 (38.7)	761 (45.6)	657 (47.8)	626 (47.3)	31 (59.6)
Declined (n = 23)	3 (0.2)	0 (0.0)	20 (1.5)	19 (1.4)	1 (1.9)
Unknown (n = 110)	44 (2.5)	28 (1.7)	38 (110)	36 (2.7)	2 (3.9)
Ethnicity (missing, 8), n (%)					
Hispanic (n = 1,317)	659 (36.8)	497 (29.8)	161 (11.8)	154 (11.7)	7 (13.7)
Non-Hispanic (n = 2,115)	937 (52.4)	697 (41.8)	481 (35.1)	469 (35.6)	12 (23.5)
Declined (n = 143)	92 (5.1)	41 (2.5)	10 (0.7)	9 (0.7)	1 (2.0)
Unknown (n = 1,250)	101 (5.7)	432 (25.9)	717 (52.4)	686 (52.1)	31 (60.8)
Diagnosis, n (%)					
Appendicitis (n = 885)	258 (14.4)	335 (20.1)	292 (21.2)	283 (21.4)	9 (17.3)
Cholecystitis (n = 1,416)	541 (30.2)	506 (30.3)	369 (26.8)	363 (27.4)	6 (11.5)
Intestinal (n = 1,280)	552 (30.9)	376 (22.5)	352 (25.6)	328 (24.7)	24 (46.2)
Peptic ulcer disease (n = 696)	245 (13.7)	262 (15.7)	189 (13.7)	182 (13.8)	7 (13.5)
Groin hernia (n = 242)	80 (4.5)	95 (5.7)	67 (4.9)	66 (5.0)	1 (1.9)
Ventral hernia (n = 274)	99 (5.5)	91 (5.5)	84 (6.2)	84 (6.3)	0 (0.0)
Necrotizing soft tissue infection (n = 40)	14 (0.8)	3 (0.2)	23 (1.7)	18 (1.4)	5 (9.6)
Mortality, n (%)	15 (0.8)	20 (1.2)	27 (2.0)	23 (1.7)*	4 (7.7)*
Length of stay, median (IQR) [range], d	3.0 (3.0) [1–147]	3.0 (4.0) [1–143]	3.0 (4.0) [1–147]	3.0 (4.0) [1–147]**	6.0 (7.0) [1–34]**

* $p = 0.0167$.

** $p < 0.001$.

IQR, interquartile range.

Continuous measures were reported as mean and SD, if normally distributed; median and interquartile ranges were applied when nonnormal. Categorical measures were reported as frequencies and percentages. Student's *t* tests (or Wilcoxon rank sum tests) were used for continuous data. Categorical group measures were compared using χ^2 statistics (or Fisher's exact tests, in cases where χ^2 assumptions were unmet). Generalized Poisson regression models were used to calculate mortality rates and 95% confidence intervals. Post hoc comparisons were used to test for significant differences between the years for each month. All statistical tests used a two-sided α of 0.05 for significance.

RESULTS

A total of 1,376 patients were admitted to NYC H + H for all 7 selected EGS diagnoses between January 1 and May 30, 2020. This was approximately a 20% decrease compared with admissions over the same period in both 2018 (1,789) and 2019 (1,668). From March to May of 2020, there were 52 (3.8%) of these EGS patients with COVID-positive status. Patient characteristics are detailed further in Table 1. Age and sex composition were similar with a median age in the fifth decade and slight male predominance across all 3 years. Payor status was also similar, with more than 75% of patients using government insurance across the years. Regarding self-reported demographics, there was an increase in nonreporting ("unknown" ethnicity) over time; however, the proportions of other racial and ethnic identifiers remained stable. Cholecystitis was the most frequent reason for admission in all 3 years, but intestinal diagnoses were the most frequent in COVID-positive patients.

To better analyze the decrease in EGS admissions in 2020, a weekly rolling average was used to track patterns of hospital admission over the 5-month period in all 3 years (Fig. 1). From

January to early March (weeks 1–11), there were approximately 9.3 to 13.8 EGS admissions per day per year, with no meaningful difference among the 3 years. The week of the March 22nd mandate (week 12), there were approximately 8.1 admissions per day in 2020, compared with 11.7 in 2018 and 12.1 in 2019. Emergency general surgery admissions for 2020 continued to decrease after this date, with a nadir of 4.2 admissions in week 14. Figure 2 compares average daily EGS admissions before and after March 22nd of each year. During 2020, there was a statistically significant decrease in average daily EGS admissions after the March 22nd mandate (11.7 vs. 9.2 admissions, $p < 0.0001$). This phenomenon was not present in either 2018 (12.0 vs. 12.2 admissions, $p = 0.71$) or 2019 (10.9 vs. 11.8 admissions, $p = 0.19$).

Both in-hospital mortality rate (7.7% vs. 1.7%, $p = 0.017$) and hospital length of stay (6.0 vs. 3.0 days, $p < 0.001$) were significantly increased in COVID-positive patients compared with those who were COVID-negative in 2020. Compared with 2019, there was a higher rate of mortality for January to May of 2020 (2.0% vs. 1.2%; however, this was not statistically significant in our study group. Looking specifically at monthly mortality after the mandate (Fig. 3), mortality was significantly increased in April (4.1% vs. 0.9%, $p = 0.045$) and May (0.4% vs. 0.0%, $p < 0.001$) of 2020 compared with 2019. Because of coding discrepancies, specifically a change in the *International Classification Diseases, Tenth Revision*, coding, 2018 was excluded from mortality analysis.

Further stratification of mortality by diagnosis category and COVID status is shown in Table 2. Intestinal diagnoses carried the highest mortality in all 3 years (1.6%, 4.0%, and 4.5%, respectively). Two categories, cholecystitis and groin hernia, had zero mortality. In four of five of the remaining categories, deaths occurred predominantly in COVID-negative patients; the exception to this was necrotizing soft tissue infection. Of the 27 EGS

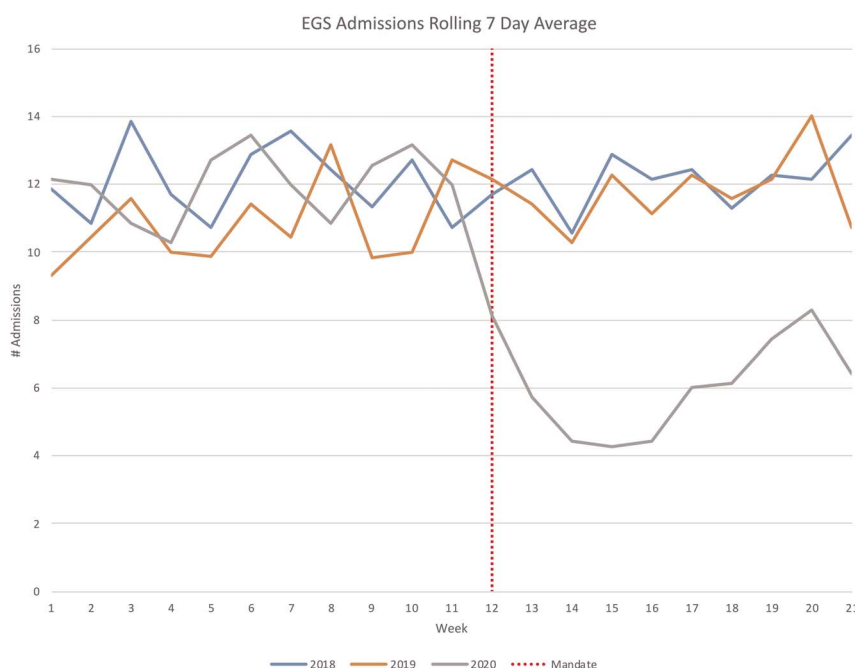


Figure 1. Seven-day rolling average of EGS admissions, January to May 2018 to 2020.

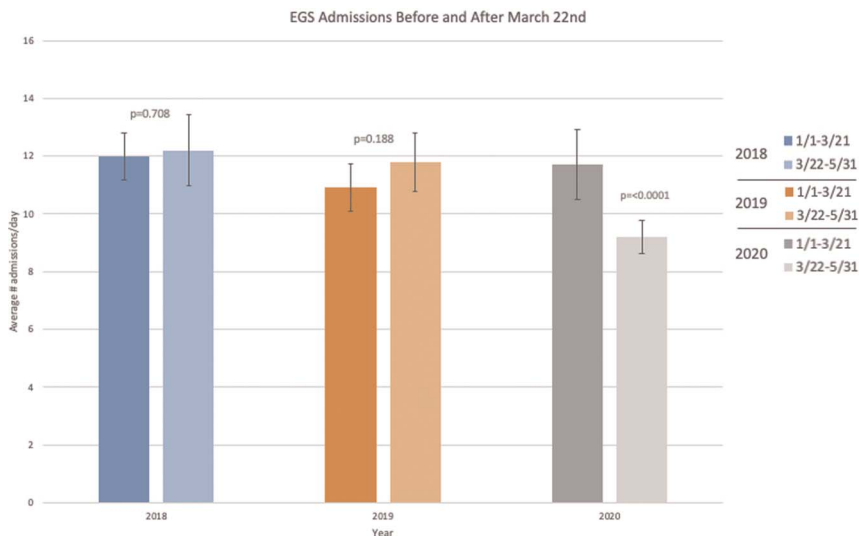


Figure 2. Comparison of average daily EGS admissions before and after March 22nd (date of stay-at-home mandate), 2018 to 2020.

patients who expired in 2020, only 4 (14.8%) were COVID positive.

DISCUSSION

The global COVID-19 pandemic changed the way surgeons practice. Many surgical societies and governing bodies have strongly recommended that hospitals cancel elective surgeries during the initial height of the pandemic.^{7,15,16} Because most health care systems obliged and elective surgeries were canceled, only true surgical emergencies remained. Our study examined the impact these societal changes had on the admission rate and mortality of EGS patients in the NYC municipal

hospital system. The findings of this study support our primary hypothesis that, during the height of the COVID pandemic in NYC in the spring of 2020, EGS admissions were noted to decline compared with the same time in 2018 and 2019. Other authors have noted a decline in the admission rates of numerous other medical and surgical diseases during similar quarantine conditions.^{10,17,18} Therefore, our observation of decreased admissions during the NYC quarantine is not completely surprising. It is not unreasonable to postulate that the decline in admissions is a direct result or in part related to the citywide stay-at-home order and generalized public fear of presenting to a hospital during the quarantine. While evidence to support this notion is scant, increased rates of home deaths in NYC

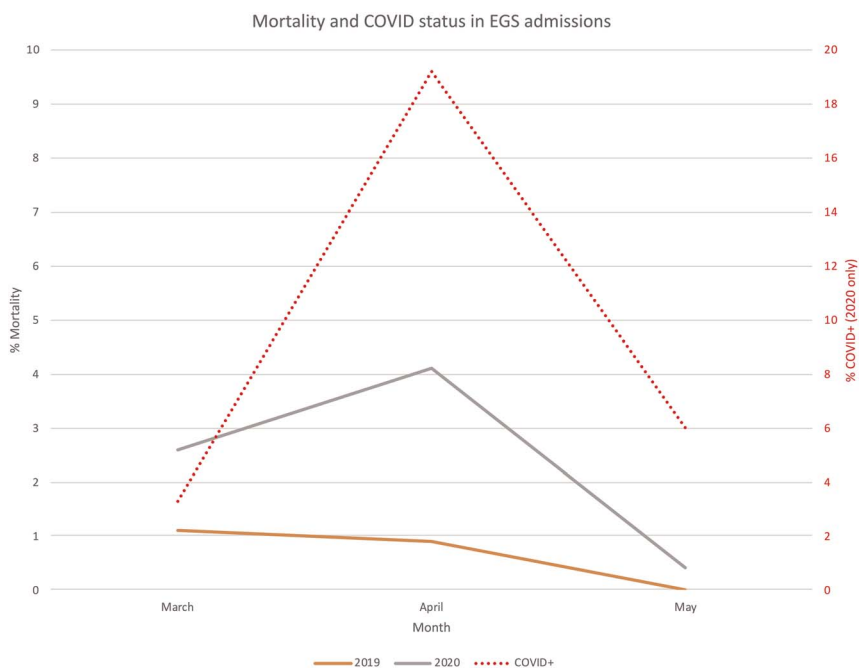


Figure 3. In-hospital mortality and COVID-infection rates for EGS admissions, March to May 2019 to 2020.

TABLE 2. In-Hospital Mortality by EGS Diagnosis and COVID Status, January to May 2020

Diagnosis	2018 n (%)	2019 n (%)	2020 n (%)	2020	
				COVID- n (%)	COVID+ n (%)
Appendicitis	0 (0.0)	0 (0.0)	1 (0.3)	1 (100.0)	0 (0.0)
Cholecystitis	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Intestinal	9 (1.6)	15 (4.0)	16 (4.5)	14 (87.5)	2 (12.5)
Peptic ulcer disease	5 (2.0)	5 (1.9)	7 (3.7)	6 (85.7)	1 (14.3)
Groin hernia	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Ventral hernia	0 (0.0)	0 (0.0)	2 (2.3)	2 (100.0)	0 (0.0)
Necrotizing soft tissue infection	1 (7.1)	0 (0.0)	1 (4.3)	0 (0.0)	1 (100.0)
Total	15 (0.8)	20 (1.2)	27 (2.0)	23 (85.2)	4 (14.8)

during its time as the epicenter for COVID have been cited as a testament to the hesitancy of the population to seek medical care.¹⁹

During this same period, there was a statistically significant increase in mortality compared with previous years in our EGS patients. This increase in mortality was highest during the peak for COVID infection rates in our population. Unfortunately, our retrospective study design and relatively small numbers make it difficult to determine causality, but nonetheless, this finding is noteworthy. The increase in mortality may reflect the proportional increase in some of the diagnoses carrying a known higher mortality, such as acute intestinal perforation. Regrettably, we were unable to determine clinically significant change in the rate of admissions across most of the diagnostic clusters owing to overall small numbers in each category. In addition, cholecystitis remained the most common EGS diagnosis across all years and does not by itself have a high mortality.²⁰ This makes it less likely that a change in the rate of various presenting diagnoses was contributing to our observed mortality difference. Interestingly, although the overall mortality rate was greater in COVID-positive patients, COVID-negative patients comprised the majority of patient deaths. This suggests that COVID infection itself was not responsible for increased deaths in the EGS patient population. An alternate reason for this finding may be that patients were presenting to the hospital with advanced disease and a higher severity of illness because of the aforementioned fears causing delays in presentation. A final possibility is the effect of patients with surgical emergencies presenting to a health care system that is already overstretched for resources because of the sheer volume of critically ill COVID-19 patients.

This study examines the impact of COVID on the EGS service in a municipal hospital system overburdened with COVID. We do not have access to data from the other five major health systems in NYC, and we cannot comment if these “missing” EGS patients presented to their facilities. However, our discussions with colleagues at other New York institutions indicate that their anecdotal experience is consistent with what was observed in this study. Aside from the aforementioned limitations, our study used retrospective billing data, which prior studies have shown to be limited by the user’s data entry. We were also unable to analyze each individual subcategory in a meaningful way owing to the small number of patients in each subcategory.

Notwithstanding and to the best of our knowledge, our study is the largest and the only multicenter study to look at EGS cases during a period of quarantine in a major COVID epicenter. We demonstrate a clear decrease in the number of EGS admissions during the spring of 2020 when NYC was the national epicenter for COVID-19. Further multicenter investigation is warranted to confirm the findings of our study and may help further delineate the reasons for the rise in mortality we see in EGS patients during the pandemic.

AUTHORSHIP

C.T.D. contributed in the study design, data analysis, article writing, submission preparation, and article revision. A.L. contributed in the study design, data analysis, article writing. E.R.L., S.M., E.C., S.H.R., J.M., and S.H.T. contributed in the article review. M.E.S. contributed in the study design, data analysis, and article review.

ACKNOWLEDGMENT

We would like to acknowledge the 24,287 New Yorkers lost to COVID-19 to date, as well as many more across the country and around the world. We would also like to thank the countless health care workers who continue to battle this pandemic every day.

DISCLOSURE

The authors declare no conflicts of interest.

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